Staged Endovascular Management of a Ruptured Intracranial Aneurysm

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Summary

The goal of treatment of ruptured intracranial aneurysms is the exclusion of the aneurysm from the intracranial circulation.

Recently endovascular techniques have provided an alternative to open surgery in selected patients. Herein, we present a patient who underwent staged endovascular procedures to achieve definitive treatment of an intracranial fusiform vertebral artery aneurysm.

Definitive immediate therapy for the aneurysm was not possible at first presentation because of the aneurysm location and configuration, and because of absence of collateral circulation. The first stage involved coiling a daughter bleb suspected of being the source of haemorrhage.

This provided acute protection against rebleeding without sacrificing the parent artery. The second and more definitive stage, delayed for 31 days, involved balloon occlusion of a fusiform aneurysm by sacrificing the parent vessel.

Introduction

The development of endovascular techniques and devices has contributed significantly to the management of ruptured and unruptured intracranial aneurysms[2,5].

Endovascular approaches to aneurysms can be categorized into those in which the aneurysm is packed with occluding coils with preservation of the parent artery, and those in which the parent artery is sacrificed with secondary occlusion of the target aneurysm. We report a case of aneurysmal subarachnoid haemorrhage in which the morphology of the aneurysm and the patient's condition obliged us to use an unconventional combination of these endovascular techniques, with an excellent outcome in a patient whose acute prognosis was very poor.

Case Report

A 26-year-old right-handed white male with a diagnosis of autosomal dominant polycystic kidney disease presented with sudden onset of the "worst headache of his life", and on examination he was noted to be confused with a diminished level of consciousness. A head CT scan demonstrated mild ventriculomegaly and extensive subarachnoid and subdural blood predominantly in the posterior fossa. While being transferred from the CT scanner, the patient suffered a respiratory arrest necessitating emergent intubation.

The patient became comatose and decerebrate, deteriorating in his Hunt and Hess classification from Grade III to V. A helical CTA (figure 1) was obtained immediately which demonstrated increased ventriculomegaly, increased intracranial blood and a fusiform aneurysm of the right vertebral artery with a protruding bleb or daughter sac. A ventriculostomy was emergently placed with minimal

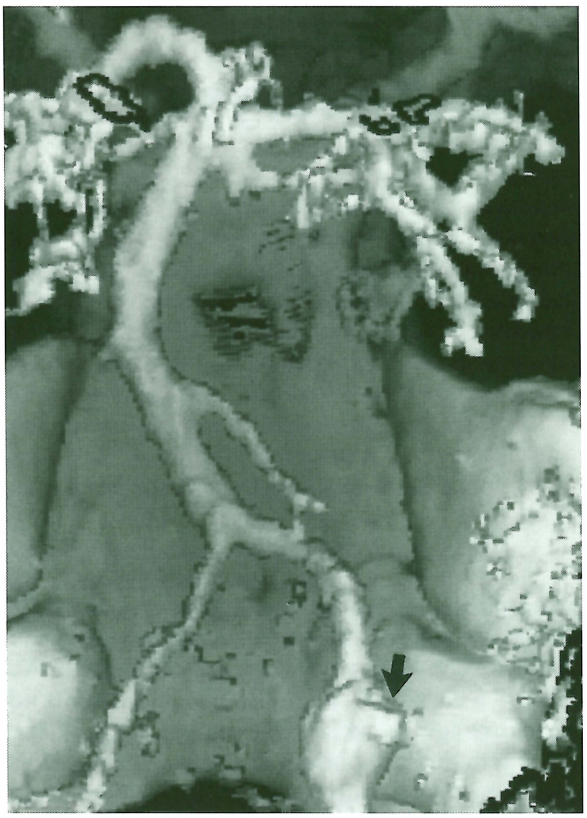

Figure 1 A 3D CTA image of the posterior fossa in an anatomic surface-rendered projection demonstrates a fusiform aneurysm of the distal intradural right vertebral artery. A prominent bleb or sac (arrow) projects from the dome.

change in the patient's neurologic status. Because of the patient's poor clinical grade, the location of the aneurysm and the limited response to ventricular decompression, the patient was considered a poor candidate for acute open surgical treatment.

Transfemoral cerebral angiography was performed to evaluate the potential for endovascular management of the aneurysm. Angiography of the posterior fossa demonstrated that the aneurysm seen on CTA was, indeed, fusiform in contour involving a short segment of the intradural dominant right vertebral artery (figure 2). Additionally, the daughter sac on the wall of the fusiform aneurysm was better defined.

The left vertebral artery, seen on the CTA, flowed retrogradely from the vertebrobasilar junction to the left posterior inferior cerebellar artery. There was no antegrade flow in the intradural left vertebral artery. The left vertebral artery origin was identified arising from the aortic arch and demonstrated complete stasis of contrast in the neck. At this time the left vertebral artery was presumed to be occluded from either severe spasm, compression from adjacent haematoma, or dissection. Bilateral carotid angiography demonstrated a double lumen tubular dissection of the left internal carotid artery, which appeared to be unrelated to the SAH. Detection of this asymptomatic carotid dissection raised the question of whether the aneurysm of the right vertebral artery might be related to an intracranial dissection or whether the occlusion of the left vertebral artery might be due to dissection of that vessel also.

More importantly, vis-à-vis our immediate therapeutic decisions, there was no significant posterior communicating artery collateral flow from the anterior circulation to the posterior circulation. Thus, the posterior circulation was completely dependent on the right vertebral artery at this time, excluding iatrogenic occlusion of this vessel as a therapeutic option. It was decided that selective coil occlusion of the aneurysmal daughter-sac represented the greatest hope of preventing aneurysmal rebleeding in the short term. Great consideration of the risks involved with this unusual procedure was given before proceeding. While it is very likely that this bleb represented the site of haemorrhage, there was also a high likelihood that it represented an extremely fragile component of the aneurysm wall.

Therefore, intraprocedural rupture of the bleb was a foremost concern in our decision-making for this patient. However, his clinical condition was by now so grave and his prognosis so poor, having sustained two episodes of haemorrhage in a 4 hour period, that we believed that preventing a third bleed from the aneurysm represented his only reasonable chance for survival.

Methods

Stage I

Mindful of the patient's propensity for intimal dissection, a 6 French introducer system was placed in the right vertebral artery. Heparinization was not used. A Tracker 10 microcatheter (Target, Fremont, CA) was deli-

cately advanced over a Seeker-Lite wire (Target, Fremont, CA) into the daughter-sac of the aneurysm. In this position a 3 mm Tracker 10 Guglielmi detachable coil (GDC) was advanced very slowly, avoiding any to-and-fro motion, and observed over a period of some minutes. The positioning appeared stable and the coil was detached. A second coil, a 2 mm Tracker 10 GDC, was advanced with similar delicacy, observed for stability, and detached. This resulted in a satisfactory filling of the aneurysm sac (figure 3).

The patient made a gradual but full neurological recovery, with the exception of visual impairment due to bilateral vitreal haemorrhages. This was ascribed to a precipitous increase in intracranial pressure and venous hypertension at the time of his second intracranial bleed, since his fundi were normal on initial presentation (Terson's Syndrome). Follow-up angiography on post-procedure day 17 demonstrated a stable appearance of the coiled daughter sac, moderate vasospasm of the basilar artery, and slight increase in size of the main body of the fusiform aneurysm. The non-dominant left vertebral artery now demonstrated antegrade flow.

Stage II

The suspected expansion of this vertebral aneurysm was concerning for future rupture. Repeat angiography on post procedure day 31 demonstrated resolution of the vasospasm. The recovery of antegrade flow in the left vertebral artery now made occlusion of the right vertebral artery a potential therapeutic option. After considering the surgical alternatives in view of the fusiform configuration of the aneurysm, it was decided to attempt closure of the right vertebral artery as definitive therapy for the aneurysm following test-occlusion. This was conducted using a 6 French system in the right vertebral artery, while a 5 French diagnostic catheter was placed at the ostium of the left vertebral artery.

Balloon test-occlusion of the right vertebral artery was tolerated by the patient over a twenty minute period under heparinization. A hand-injection of contrast via the left vertebral artery was performed during that time demonstrating

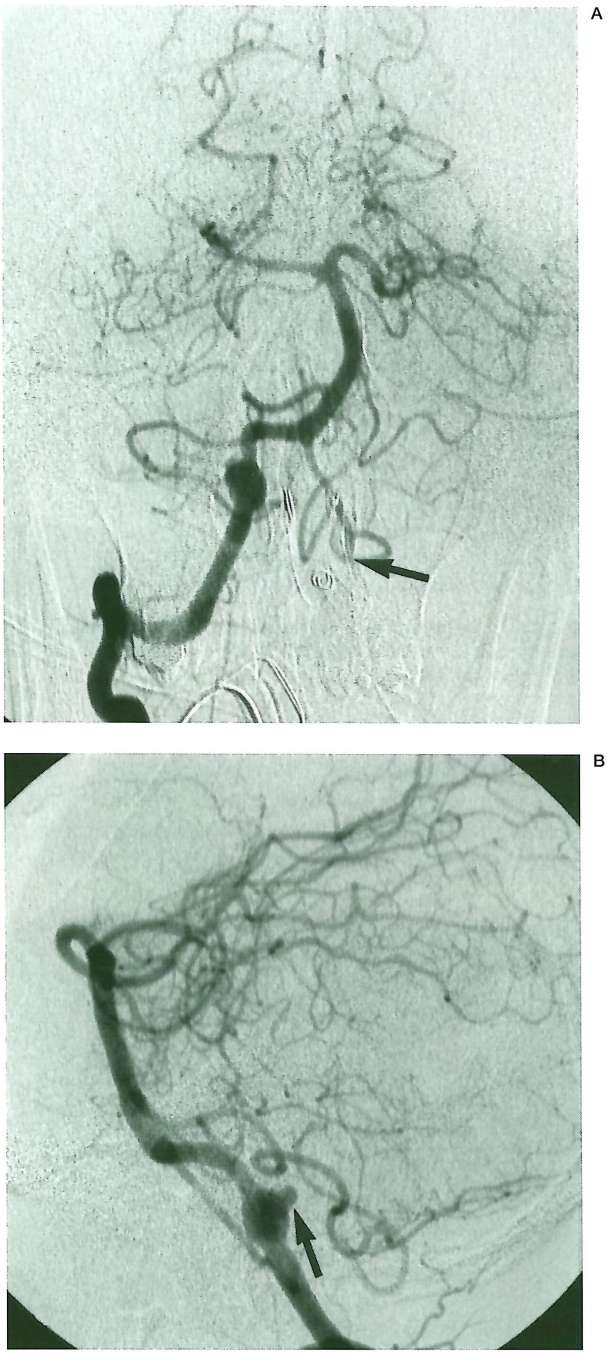

Figure 2 An AP (A) and lateral (B) view of the right vertebral artery fusiform aneurysm. Flow to the left posterior inferior cerebellar artery occurs retrogradely from the vertebro-basilar junction, with no antegrade washout of contrast (arrow in A). The injection in the right vertebral artery was performed by gentle hand-injection to avoid risk of rupturing the aneurysm. The sustained opacification of the left vertebral artery and left posterior inferior cerebellar artery with this gentle technique could by achieved only if the left vertebral artery were completely occluded, as had already been seen. The left vertebral artery arose from the aortic arch and demonstrated stagnation of contrast in the lower neck.

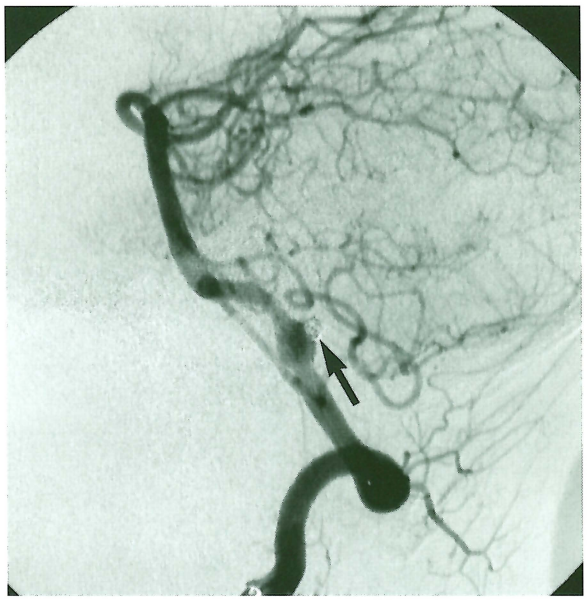

Figure 3 A lateral view of the right vertebral artery at the completion of coil-occlusion of the daughter-sac of the aneurysm (arrow).

prompt antegrade flow in all the vessels of the posterior circulation. The right vertebral artery was then sacrificed between C1 and C3 with a series of #16 latex balloons (Nycomed, France). Post occlusion angiography of the left vertebral artery demonstrated reflux into the intradural right vertebral artery (figure 4). Faint slow opacification of part of the aneurysm was seen late in the run.

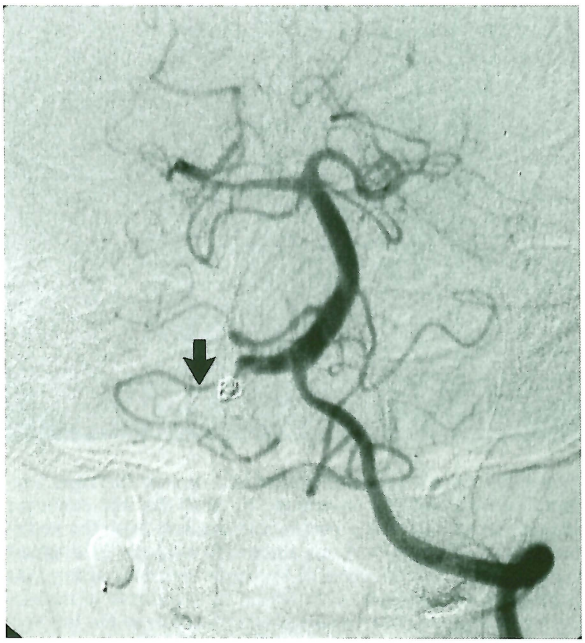

Figure 4 An AP view post-occlusion of the right vertebral artery demonstrates perfusion of the posterior circulation via the left vertebral artery. Retrograde flow to the distal intradural right vertebral artery is maintained.

The patient tolerated the procedure without incident. Since that time, he has made a full recovery from his illness with the exception of aforementioned visual impairment manifesting with diminution of central vision despite bilateral vitrectomies. Within four months of his initial haemorrhage he resumed full-time employment.

Discussion

The association of intracranial aneurysms with autosomal dominant polycystic kidney disease (ADPKD) is well established, though the biochemical and structural substrate has yet to be completely defined. The prevalence of intracranial aneurysms among adults with ADPKD varies between 11- 24% [1]. This case was somewhat atypical in that most intracranial aneurysms associated with ADPKD are berry-type aneurysms whereas our patient had a fusiform aneurysm. Furthermore, the presence of an unexpected carotid dissection in this patient raises the question of whether his propensity to aneurysm formation may have been related to a less well recognized underlying diathesis of the connective tissue, causing an intracranial dissection of his right vertebral artery. This was considered as a possibility at the time of treatment, although it was noted that the typical "pearl and string" sign for intracranial dissection was not demonstrated.

Hunt and Hess Grade V patients following rupture of a posterior circulation aneurysm carry a poor prognosis with a high surgical morbidity (<20% favorable outcome) [3,4]. Because of the high surgical morbidity, many centers have favored acute endovascular treatment of poor grade posterior circulation aneurysms, with promising results. In our case, the options for endovascular management were limited because of the fusiform nature of the aneurysm, the lack of flow in the contralateral vertebral artery, and the paucity of communication between the anterior and posterior circulation. The only reasonable options at the time of his initial presentation were to observe the

patient or to treat the patient by unconventional methods. Under normal circumstances the authors' preference would be to avoid placing coils directly into a ruptured daughter sac or bleb. The risks of perforating the aneurysm wall during such a procedure are probably high, and in general it is probably safer to pack the aneurysm body itself and thus exclude a daughter sac or bleb from the arterial tree. However, coil-occlusion of the aneurysm body itself in the first instance was not possible due to the fusiform configuration and the need to preserve the right vertebral artery.

The reason for the initial occlusion of the left vertebral artery in this patient is not clear. Hyperacute spasm close to the site of haemorrhage can occasionally be seen in patients with sub-arachnoid haemorrhage, although it was not otherwise evident in this patient. In light of his asymptomatic carotid dissection, it is possible that he sustained an occlusive dissection of the left vertebral artery which subsequently recanalized. This possibility was considered but no evidence for such could be seen on the later angiograms. Another possibilty might have been spasm of the left vertebral artery associated with musculoskeletal trauma at the time of his respiratory arrest during his second haemorrhage.

It is possible that this patient without intervention might have recovered from his initial haemorrhages without further bleeding and that delayed therapy would have been possible in any instance. Having already sustained two haemorrhages and having deteriorated clinically to a Hunt and Hess Grade V, we could not have been confident of his ability to do this. Ruptured aneurysms of the posterior fossa with a clinical Grade V have a very poor prognosis for survival without definitive treatment [4]. Certainly another bleed from the unsecured aneurysm would have reduced his chances of survival still further.

This patient demonstrates that in difficult circumstances where therapeutic options are restricted, less than definitive therapy acutely does not necessarily portend a suboptimal outcome. For this patient, the unconventional and riskly maneuver of initially securing the ruptured daughter sac of the aneurysm through endovascular means was sufficient to allow him to recover in the acute phase.

In this case, packing of the presumed site of aneurysm rupture as an initial procedure effectively temporized until clinical recovery and resolution of vasospasm could take place. (It should be noted however that the risks of performing such a procedure are probably substantial and that this particular procedure was done with the *most* delicate manipulation of coils. The authors' recommendation is to avoid directly catheterizing aneurysm blebs or daughter-sacs if possible.) With the delayed re-establishment of flow in the left vertebral artery, our therapeutic options could include right vertebral artery occlusion. Though occlusion could not be considered acutely, it ultimately provided definitive treatment in this case.

Occasionally, definitive therapy of aneurysms requires combining and staging open surgery and endovascular techniques. The treating physicians need to keep an open mind to staging the treatment of complicated lesions especially when dynamic pathophysiology such as vasospasm is imminent or threatening.

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